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(56) Documents cited
None

(58) Field of search
H4F

(54) Television projection apparatus

(57) An incoherent light source such as an arc-lamp 2 illuminates a linear light modulator 1 e.g. a row of light valves, controlled by a video line signal. The video line image is projected onto a screen 5 *via* an oscillating 4 or multi-faced mirror, the scannning being synchronised to the modulator 1 video information such that a complete image is projected.

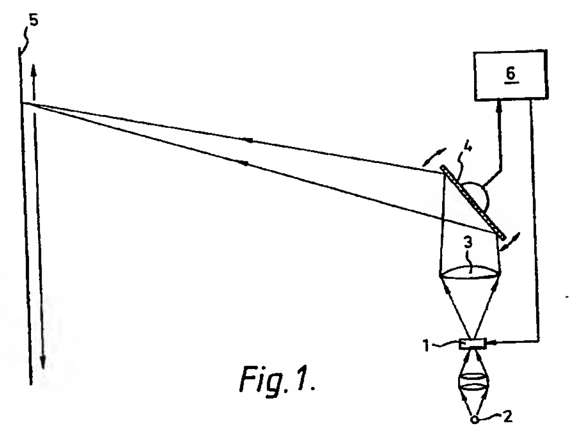

Fig. 1.

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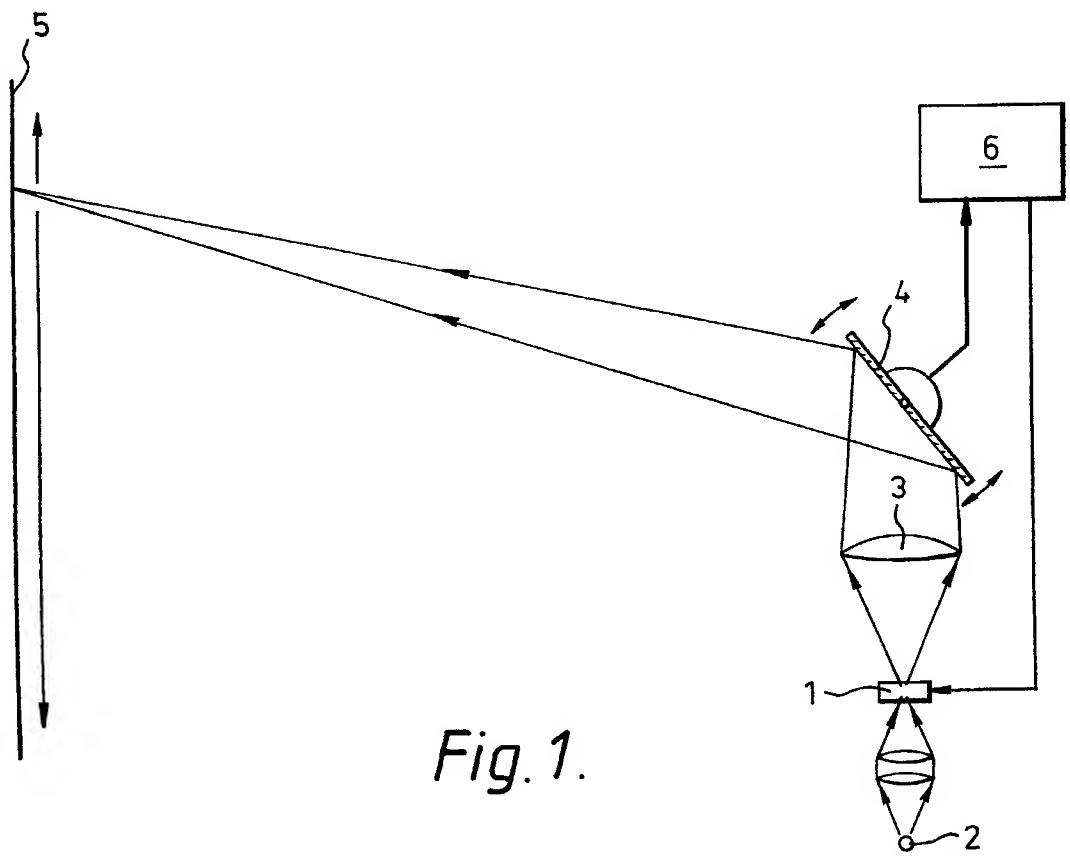


Fig. 1.

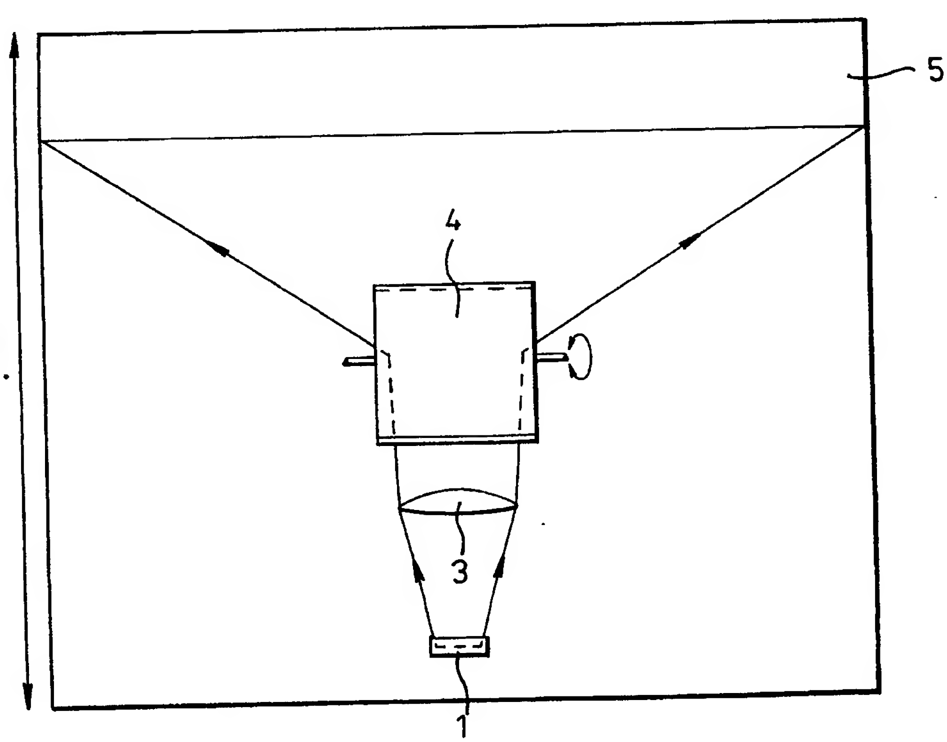


Fig. 2.

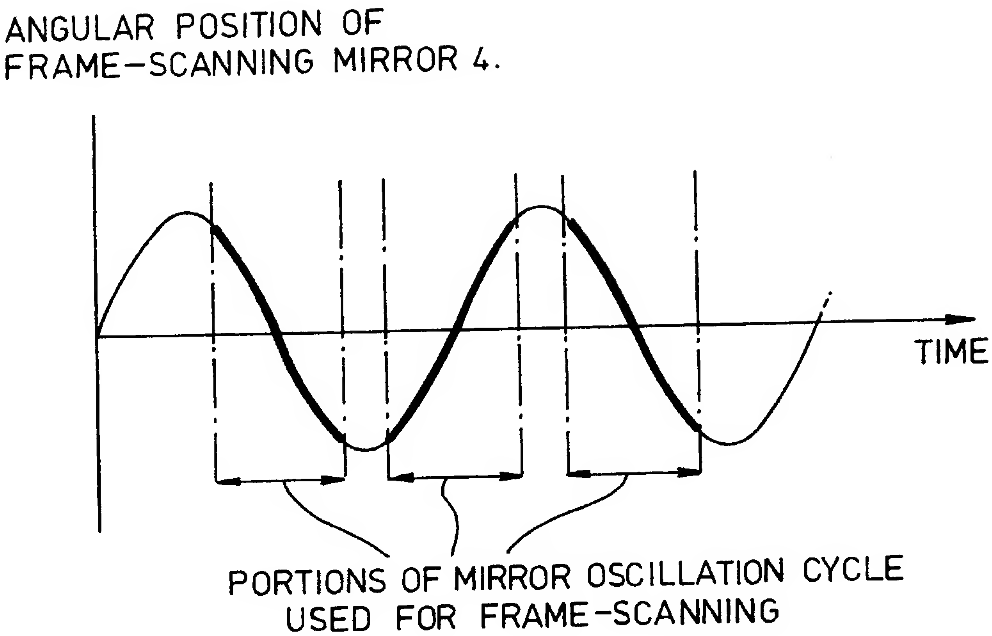

ANGULAR POSITION OF FRAME-SCANNING MIRROR 4.
TIME
PORTIONS OF MIRROR OSCILLATION CYCLE USED FOR FRAME-SCANNING

Fig. 3.

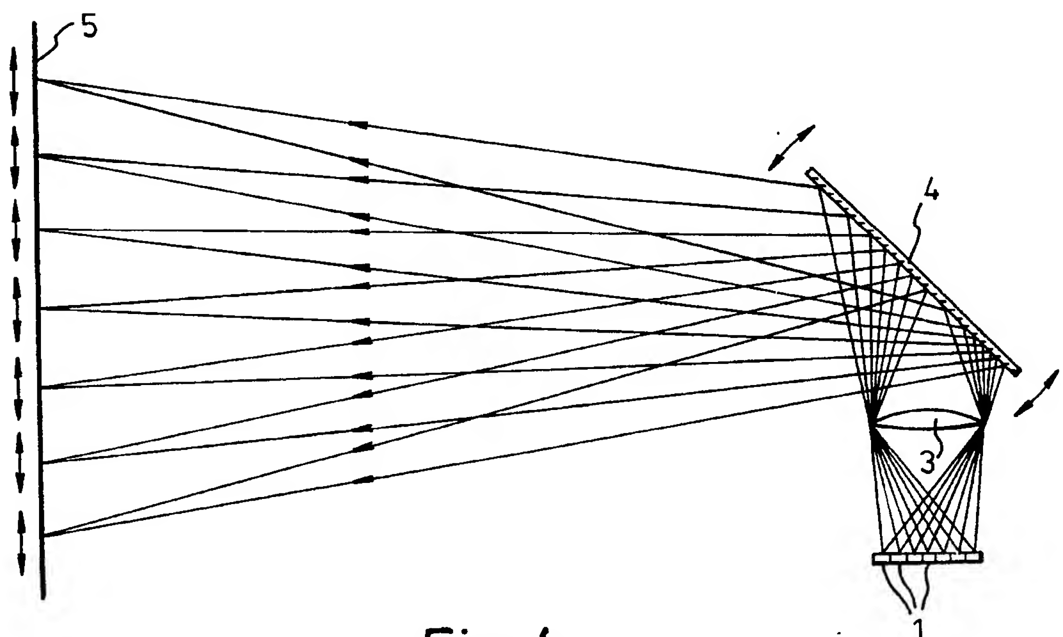

5
4
3
1

Fig. 4.

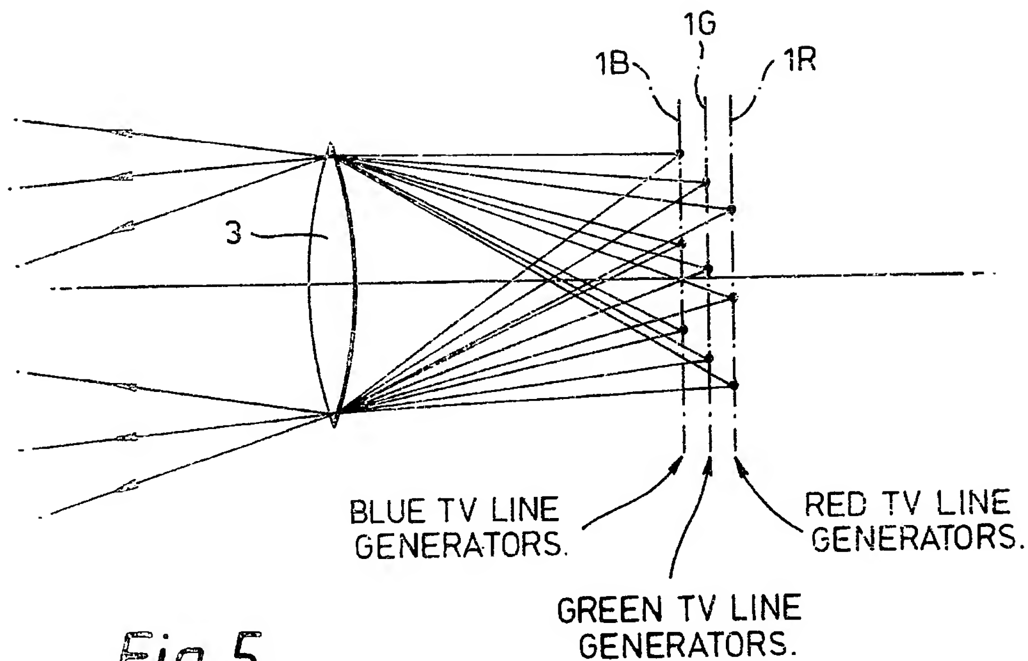

1G
1B
1R
3
BLUE TV LINE GENERATORS.
GREEN TV LINE GENERATORS.
RED TV LINE GENERATORS.

Fig. 5.

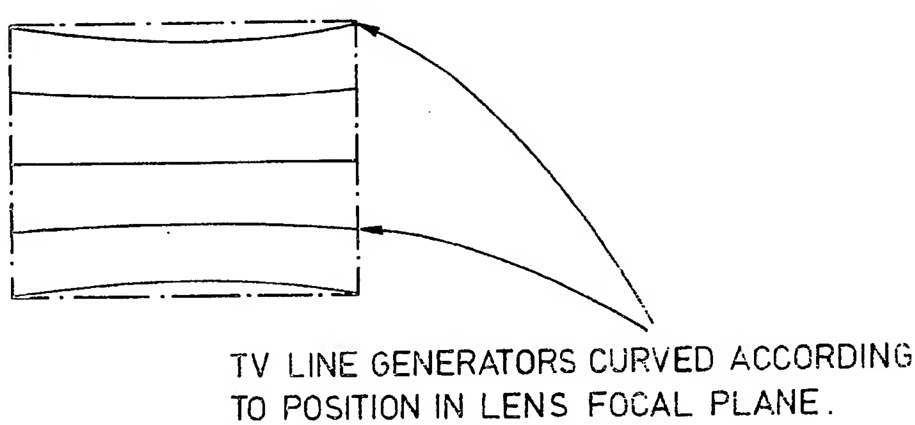
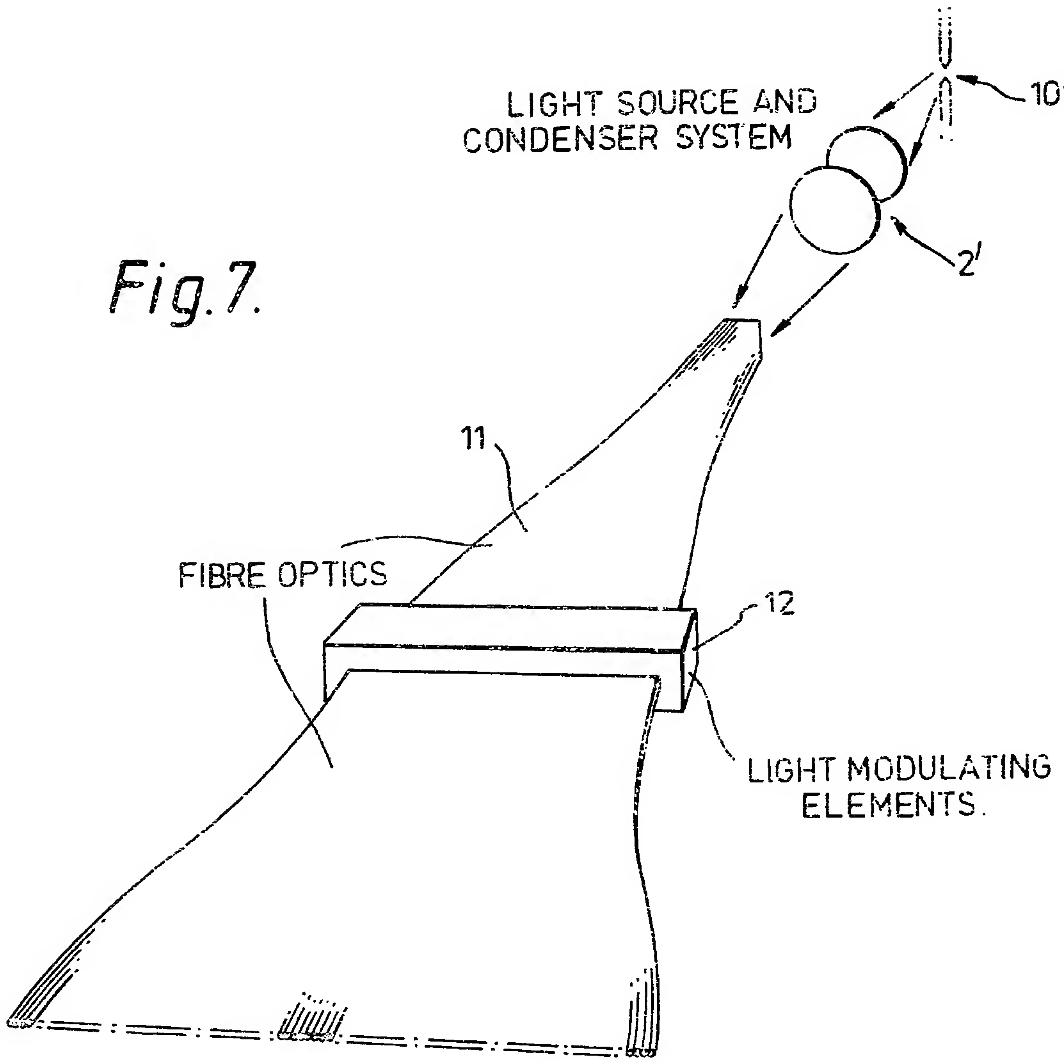

TV LINE GENERATORS CURVED ACCORDING TO POSITION IN LENS FOCAL PLANE.

Fig. 6.

Fig. 7.


LIGHT SOURCE AND
CONDENSER SYSTEM
10'
2'
11
FIBRE OPTICS
12
LIGHT MODULATING
ELEMENTS.

SPECIFICATION

Television project system

The invention relates to a television projection system.

Known TV projectors may be classified broadly into three groups. The first group is based on the use of one or more cathode ray tubes (CRTs) in conjunction with an optical projection system comprising one or more mirrors or lenses. The optical projection system forms an image of the CRT faceplate on a remote viewing screen to provide a large TV picture. In practice, limitations on achievable phosphor brightness limit the available light output from such TV projectors to a value typically in the range 100-1000 lumens, the upper figure demanding large, high brightness CRTs and large aperture projection optics. Furthermore, high contrast and resolution are difficult to maintain in the picture when the phosphor layer generating the primary image is being driven hard to maximise light output, while colour registration is often poor, at least over part of the picture area, because the most efficient way of projecting a coloured image is to use three separate coloured CRTs, necessitating complex geometrical coverage adjustments to obtain correct superimposition of the red, green and blue images on a remote screen.

In the second group of projectors, a static optical projection system is retained, but the CRT phospher is replaced by a layer whose optical transmittance or reflectance can be altered locally by suitable electronic addressing means, to achieve a transmissive or reflective passive image which may be projected using suitable incident illumination. Such TV projectors are often referred to as light valves; their extremely high potential light output stems from the replacement of a limited brightness phospher layer with a source image (eg Xenon arc) having up to ten thousand times greater intrinsic brightness. Known devices include the Gretag Eidophor and General Electric projectors (oil control layer deformed locally by scanned electron beam to yield TV image in conjunction with schlieren projection optics), the LEP Titus projector (electro-optic crystal layer in which locally induced birefringence creates a reflective image in conjunction with crossed polarisers) and the Hughes liquid crystal projector (another polarisation-based device using a liquid crystal layer). These systems are capable of light outputs in the range 300-7000 lumens, but only the high intensity Eidophor can approach the upper figure using massive, expensive hardware.

In theory, much greater light output should be obtainable from light valve projectors: ignoring transmission losses and heat dissipation problems, an f/1.4 lens collecting light from a 50 mm × 50 mm arc source image could project over 350,000 lumens. However, in practice light is lost through unavoidable transmission losses and aperture limitations in the optical systems employed, and there are generally power handling limitations (thermal control problems) associated with the light valve layer itself.

The third group of TV projectors comprises optical beam scanners in which one or more beams of light of specified wavelength are scanned in raster fashion over a remote screen by a combination of optical line- and frame-scanning systems. The line- and frame-scanning systems are synchronised with incoming TV signals which are used to modulate the beam intensities as required to produce a TV picture. With appropriate system design, this type of scanner can achieve very high resolution, high contrast and excellent colour registration. However, in order to achieve efficient line- and frame-scanning using known devices, the optical beam must be of small diameter and low divergence, necessitating the use of laser sources to achieve a reasonable light output. Laser colour TV projectors currently under development are limited to around 1000 lumens output by the characteristics of available lasers.

A TV projector according to one aspect of the invention incorporates no light-emitting CRT devices, but includes one or more linear array light modulators to generate one or more complete TV lines, together with an optical frame-scanning mechanism.

A preferred arrangement of TV projector according to the invention will now be described by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a side view of the TV projector according to the invention,

Figure 2 is a rear view of the TV projector of Figure 1,

Figure 3 shows in graphical form oscillations of the mirror and parts of the oscillations which are used for frame-scanning,

Figure 4 shows a side view corresponding to part of Figure 1 of an alternative arrangement of the invention,

Figure 5 shows an arrangement in which three modulators may be used to produce three colours for colour television projection,

Figure 6 shows the way in which the TV line generators may be curved according to the position in the lens focal plane, and,

Figure 7 shows an alternative arrangement incorporating fibre optics.

Figures 1 and 2 show the basic configuration of a projector using a single linear array modulator. In Figures 1 and 2, an array modulator 1, brightly illuminated by a suitable source and condenser system 2, and controlled to display one full line of a complete TV picture, is imaged by a lens 3 onto a viewing screen 5 via a moving mirror 4, oscillating at the normal TV frame rate. As the mirror oscillates, the image of the linear array modulator (the TV "line") is swept down the screen generating the illusion of a continuous display image. The instantaneous position of the frame-scanning mirror 4 is accurately encoded and used to trigger the output of appropriate TV line information from the TV frame store 6 to the array modulator 1.

The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

In order to provide a light output competitive with established TV projectors, the optical components shown in Figure 1 are relatively large. Using an efficient array modulator 1 approximately 200 mm long containing 800 discrete elements, an f/1.4 lens 3 approximately 300 mm in diameter and an oscillating plane mirror 4 approximately 450 mm square, a peak output in excess of 2000 lumens is achievable. It is however difficult to drive such a large oscillating mirror through an angle of perhaps 10° to achieve a linear angular scan with fast flyback at a repetition rate of 50-60 Hz because of the enormous torque required to accelerate the inertial load associated with the mirror. We have, however, adopted a resonant oscillating system for the mirror mount to achieve an adequate deflection angle, using as much as possible of the resulting sinusoidal scan to minimise dead time in the frame-scanning mechanism using appropriate timing pulses and a sufficiently versatile TV line readout mechanism, 80% or more of the sinusoidal frame scan can be employed on both the upward and downward sweeps of the mirror, as indicated in Figure 3.

It is preferred that several TV lines from either several linear array modulators 1 or from a matrix array modulator are projected simultaneously as shown in Figure 4. Benefits of such an arrangement include a proportional increase in light output, with simultaneous reduction in the vibrational amplitude required from the frame scanning mirror. In addition, the response time associated with individual array modulators may be proportionally increased without detriment to picture quality. As stated above, appropriate encoding pulses in conjunction with a sufficiently versatile frame store readout mechanism would enable the correct TV line information to be fed simultaneously to several array modulators.

To provide a TV display in full colour, the lens 3 in Figures 1 and 2 is, in one embodiment, and achromatic projection lens and the linear array modulators comprise interleaved red, green and blue transmitting elements. A preferred configuration employs separate linear modulators 1 comprising entirely red, green or blue transmitting elements, thereby allowing full TV line resolution to be maintained in all colours. Although individual coloured TV line generators may be separated in the focal plane of the projection lens, appropriate distribution of TV line information from the TV frame store ensures correct superimposition of the red, green and blue coloured images on the viewing screen 5.

Some of the design problems and expense associated with providing a large lens 3 of adequate optical performance may be eased by altering the geometry of the linear array modulators forming individual TV lines. This facility is particularly useful when several red-, green- and blue-transmitting linear modulators are employed to provide a colour TV projector with a very large output. For example, in one arrangement the red, green and blue linear modulators 1R, 1G, 1B lie respectively in adjacent parallel planes displaced along the axis of the projection lens 3, as shown in Figure 5 to reduce the degree of colour correction required in the lens. Furthermore, individual linear modulators 1 may be curved according to their position in the focal plane of the lens 3 as shown in Figure 6, to correct residual geometrical distortion of the lens 3. In some cases it is beneficial to include convex or concave curvature of the arrays 1 towards the projection lens 3 to compensate for residual field curvature.

In order to provide a compact optical system with efficient illumination of indivual TV lines, which may incorporate distortion correction as outlined above, a preferred arrangement employs optical fibres 11 to guide light from a suitable source 10 to the focal plane of the projection lens 3 via an array of individual modulator elements 12 as indicated in Figure 7. Each element of the modulator array 1 controls the intensity of light transmitted by a single fibre. The fibres 11 would be formed into one or more linear arrays in the focal plane of the lens 3 to constitute one or more complete TV lines for projection by the lens 3.

As an alternative to the large frame-scanning mirror external to the projection lens 3, a smaller frame-scanning mirror could be interposed between the projection lens 3 and the linear array modulators 1, or the array modulators themselves (or the projection lens) could be vibrated to achieve frame scanning.

We have thus described a TV projector using conventional light sources in which one or more complete TV lines are generated by one or more brightly-illuminated, parallel-driven, linear array modulators, the TV line generators being imaged onto a remote viewing screen by a suitable projection lens and frame scanning being provided by a vibrating plane mirror or by relative motion between the TV line generators and the projection lens.

One or more TV frame stores may be used to distribute TV line information to one or more TV line generators at appropriate times during the frame-scanning cycle.

The frame scanning timebase may be distorted to suit the characteristics of a resonant vibrating mechanism.

A full colour image may be provided by the use of one or more linear array modulators transmitting predominantly blue, green or red light respectively.

The shape and location of individual linear array modulators in the focal plane of the projection lens may be adjusted to compensate for deficiencies in the performance of the lens.

The TV line generators may be constructed using optical fibres.

CLAIMS

1. A projector apparatus comprising an incoherent light source, a line modulator as defined, means for passing light from the light source to the line modulator, means for passing a video signal to the line modulator, and means for passing the light influenced by the line modulator to a screen, the light passing means including a scanning apparatus to scan the part image formed by the line modulator across the screen to build up at least part of an image.

2. Apparatus as claimed in claim 1 in which there is provided more than one line modulator.

3. Apparatus as claimed in claim 2 in which each line modulator is arranged to receive a video signal in respect of different parts of the complete image.

4. Apparatus as claimed in claim 2, in which there

are at least three line modulators, there being provided at least one line modulator for each video signal relating to the green, the red, and the blue component of the image.

5. Apparatus as claimed in any of claims 1 to 4 in which the or each line modulator comprises a plurality of discrete components.

6. Apparatus as claimed in any of claims 1 to 4 in which the or each line modulator comprises a single component arranged to transmit or reflect incident light to a different extent along its length.

7. Apparatus as claimed in any of claims 1 to 6 in which the light from the light source passes to the line modulator and is thereby modulated in respect of its intensity, and is transmitted through the line modulator to the screen.

8. Apparatus as claimed in any of claims 1 to 6 in which the light from the light source is passed to the line modulator, is reflected therefrom with an intensity which is modulated by the line modulator, and the reflected light is passed to the screen.

9. Apparatus as claimed in any of claims 1 to 8 in which the line modulator is curved.

10. Apparatus as claimed in any of claims 1 to 9 in which the scanning apparatus comprises a movable mirror.

11. Apparatus as claimed in claim 10 in which the movable mirror comprises an oscillating mirror.

12. Apparatus as claimed in claim 10 in which the movable mirror comprises a plurality of mirrors in the form of a mirror drum which is rotated about its axis.

13. Apparatus as claimed in any of claims 1 to 9 in which the scanning apparatus comprises one or more movable lens.

14. Apparatus as claimed in any of claims 1 to 13 in which the light is passed to and from the or each line modulator by optical fibres.

15. Apparatus as claimed in claim 5 and claim 14 in which light is passed to each discrete component by an associated optic fibre and from each discreet component by a respective optic fibre.

16. Apparatus as claimed in claim 15 in which the scanning means comprises means to move the optical fibres.

17. A projector apparatus as claimed in claim 1 substantially as hereinbefore described with reference to the accompanying drawings.

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